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TITLE

MESSAGE TRANSFER PART POINT CODE MAPPING METHOD AND NODE

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BACKGROUND OF THE INVENTION

Technical Field

The present invention relates to Signaling System 7 (SS7/C7) networks and, more particularly, to a mapping function and method for transmitting signaling messages from a first licensed operator network to a second licensed operator network, where both operator networks use the same national numbering plan to assign point codes identifications.

History of Related Art

The evolution of telecommunication networks has resulted in a need today for using international gateways, Global Title databases and Point Code databases that require complex and precise inter-working coordination between rival licensed operator networks to ensure the proper delivery of signaling messages.

As is known in the art, network nodes route SS7/C7 signaling messages within the SS7/C7 network and manage the various signaling links which comprise the SS7/C7 network. Routing is accomplished by processing a routing label of the SS7/C7 signaling message by a Message Transfer Part (MTP) functionality of a signaling point (SP). The MTP comprises three levels. Levels 1 and 2 facilitate the transfer of signaling messages from one point to another point over an individual signaling link. Level 3 facilitates the transfer of signaling messages over SS7/C7 networks beyond the requirements of the individual signaling links. In other words, levels 1 and 2 are concerned with transport over individual links whereas level 3 is concerned with transport over SS7/C7 network in general.

A node accomplishes its routing task at level 3 through the use of point codes, which identify the various signaling points in the network. The MTP level 3 of the node identifies the destination point code in the signaling message and selects the proper signaling link for routing that message.

For example, if node A sends a signaling message to node B through a Signaling Transfer Point (STP), the message contains the origination point code for the signaling point in node A and the destination point code for the signaling point in node B. The STP accepts this message from one signaling link, reads the destination point code, and places the message on the appropriate link for node B.

Based on that, rival licensed operator networks, in order to exchange signaling messages, need to interconnect their SS7/C7 networks using gateways and complex inter-working configuration management schemes such as Global Titles or Point Codes, which requires a complex inter-working coordination to ensure proper delivery of signaling messages. This complex inter-working coordination between the operator networks increases the risk of inaccuracies during the definition of the Point Code databases. Such inaccuracies may result in Point Code conflicts for many operators and cause problems such as circular routing (signaling message routing continuously back and forth) due to duplication of Point Codes. For example, this problem occurs when the operator network defines a node with a Point Code which is already used by another node within the same operator network or a rival operator network thus resulting in incorrect routing information. The incorrect routing information causes each processed signaling message to be routed repeatedly between nodes with the same Point Code without reaching its final destination. This circular routing condition continues indefinitely and may lead to network congestion and possible failure within the network.

Repeating Point Codes are also dangerous. For one thing, any one node cannot route towards two different nodes, which use the same Point Code. But worse, if one such node fails, all its neighbors will broadcast management messages (such as, Transfer Prohibited, TFP) which will be sent throughout both networks and stop all signaling to both the failed node and the healthy node.

SUMMARY OF THE INVENTION

The invention discloses a method and network node that solves the problems originated by the complex inter-working coordination necessary between operator networks during the definition of the Point Code databases and the resulting conflicts due to circular routing. Message Transfer Part (MTP) Point Code Mapping is a facility that allows different operators in the same national network to assign Point Codes independently, so the same Point Code may be used for two or more nodes. This improves the interconnection of global operators connected to several national networks and improves the interconnection of operators inter-working with other operators.

One embodiment of the method of the invention includes the step of receiving in the MTP of a Border Node of a first network, an outgoing signaling message to be sent to a second network. This signaling message includes routing information (OPC and DPC) in a corresponding first network own numbering plan of Point Codes values. The MTP of the Border Node then maps the OPC and DPC from the first network own numbering plan to a corresponding second network external numbering plan values based on a selected Link Set having an associated mapping table of Point Codes. The MTP of the Border Node then delivers the signaling message to the adjacent network based on the mapped Point Code values.

In another embodiment, the invention describes a method for handling incoming signaling messages received from the second network. The method starts when an incoming signaling message is received in the MTP of the first network Border Node from the second network, signaling message which includes the routing information (OPC and DPC) in the external numbering plan of Point Codes values. The MTP of the Border Node then maps the OPC and DPC from the external numbering plan to the corresponded first network own numbering plan values based on a Link Set (from which the incoming message is received) having an associated mapping table of Point Codes. The MTP of the Border Node then delivers the signaling message to the destination node based on the mapped Point Code values.

The invention is operable on a per Link Set basis and only one Border Node (of the Border Nodes interconnected by the Link Set) supports the MTP Point Code Mapping method for outgoing and incoming signaling message. Therefore each adjacent operator can have a different mapping and a different domain of accessible Point Codes. If the Border Node has a Link Set defined with the mapping function applied, it will perform mapping for all the outgoing messages and the incoming messages.

In another embodiment, the present invention is a network node that applies Message Transfer Part functions to signaling messages that contain point codes, wherein the network node applies MTP level 1 function, MTP level 2 function, MTP level 3 function and MTP level 4. The MTP level 3 includes a means for mapping the point codes in the signaling message into different point codes in a different numbering plan than the numbering plan of the Point Codes originally contained in the signaling message.

The invention includes a network, wherein the network includes a first and a second licensed operator network, the first licensed operator network includes a Border Node, the first and second licensed operator network assign Point Codes according to the same numbering plan, and the Border Node includes a MTP Point Code Mapping Table for the Link Set that connects the Border Node in the first licensed operator network to an adjacent Border Node in the second licensed operator network, the MTP Point Code Mapping Table associates an alias Point Code assigned in the first licensed operator network to a node in the second licensed operator network with the actual Point Code for that same node in the second licensed operator network. Based on the MTP Point Code Mapping Table associated with the Link Set that connects the Border Node in the first licensed operator network and the adjacent Border Node in the second licensed operator network, the Border Node in the first operator network maps the Point Code values for outgoing signaling message from own numbering plan to a external numbering plan and for incoming signaling message, the Border Node maps the Point Code values from the external numbering plan to own numbering plan.

The invention also includes a database for MTP Point Code Mapping Tables, wherein the MTP Point Code Mapping Tables includes a first identity field for an associated Link Set; a second identity field associated with Point Codes in an own numbering plan; and a third identity field associated with Point Codes in an external numbering plan. The first identity field typically contains the Link Set Identification of the Link Set associated to the MTP Point Mapping Table. The second identity field typically contains the Point Code values associated with the own numbering plan; and the third identity field contains the Point Code values associated with the external numbering plan.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete understanding of the structure and operation of the present invention may be had by reference to the following detailed description when taken in conjunction with the accompanying drawings, wherein:

FIG.1 shows a block diagram of a typical SS7/C7 network, where the MTP Point Code Mapping method is used in the scenario of sending outgoing signaling messages;

FIG.2 shows a block diagram of a typical SS7/C7 network, where the MTP Point Code Mapping method is used in the scenario of receiving incoming signaling messages;

FIG.3 shows a flow chart of MTP Point Code method used for outgoing signaling message;

FIG.4 shows a flow chart of MTP Point Code method used for incoming signaling message; and

FIG.5 depicts a functionality of network node and elements of a database for MTP Point Code Mapping.

DETAILED DESCRIPTION OF PREFERRED EXEMPLARY EMBODIMENTS

Referring to FIG. 1, there is shown a block diagram of a typical SS7/C7 network, where the MTP Point Code Mapping method is used in the scenario of sending outgoing signaling messages. In this case, three-licensed operator networks **20**, **30**, and **40** compose a national telecommunication network **10**. The first licensed operator network **20** includes nodes **50**, **60**, and **70**, where the node **70** acts as a Border Node toward the second licensed operator network **30** and third licensed operator network **40**. As it can be seen, in the first licensed operator network **20**, various Link Sets **80** connect the originating node **50**, the node **60**, and the Border Node **70**. The second licensed operator network **30** includes nodes **90**, **100**, and **110**, where the node **90** acts as Border Node toward the first licensed operator network **20**. As it can be seen, in the second licensed operator network **30**, various Link Sets **120** connect the node **90**, the node **100**, and the node **110**. Also the third licensed operator network **40** is composed by Border Node **130** (toward the first licensed network **20**) and node **140**, which are connected through a Link Set **150**.

The Border Node **70** (in the first licensed operator network **20**) is interconnected toward an adjacent Border Node **90** (in the second licensed operator network **30**) by a Link Set (**160**) and toward an adjacent Border Node **130** (in the third licensed operator network **40**) by a Link Set (**170**). In Message Transfer part (MTP) level 3 of the Border Node **70** are stored Point Code Mapping tables **190** and **195**, which are associated with the Link Sets **160** and **170**, respectively. The Border Node **70** can act such as a Signaling Transfer Point (STP) or a Signaling End Point (SEP). It should be recognized that an STP can originate and receive signaling messages as well as having the ability to transfer signaling messages from one node to another; and that an SEP can only originate and receive messages, it has no transfer function. The Border Node **70** must work with Link Sets provided of a dual numbering plan for Point Codes: its own plan, and the external numbering plan of the adjacent licensed operator network(s) **30** and **40**.

An important characteristic of this national telecommunication network **10** is that the MTP Point Code Mapping method is applicable to Border Nodes and for the Link Sets that interconnect these Border Nodes. In other words, for example for the Border Nodes **70** and **90** which are interconnected by the Link Set **160**, only one Border Node (in this case the Border Node **70**) has the MTP Point Code Mapping method active for the Link Set **160** and therefore this node performs the MTP Point Code Mapping for outgoing and incoming signaling messages (the scenario of incoming signaling message is described in FIG.2). Otherwise, a circular routing condition between Border Nodes **70** and **90** occurs because of double mapping if both Border Nodes have the MTP Point Code Mapping method active.

Another important characteristic of this national telecommunication network **10** is that the three licensed operator networks **20**, **30**, and **40** are using the same numbering plan to identify their respective own nodes. This can be seen in the first licensed operator network **20** where its numbering plan identifies the nodes **50**, **60**, and **70** with the Point Codes 2-B, 2-C, and 2-A respectively. In the second licensed operator network **30**, the numbering plan identifies the nodes **90**, **100**, and **110** with the Point Codes 2-E, 2-B, and 2-A. In the third licensed operator network **40**, it identifies its nodes **130** and **140** with the Point Codes 2-R and 2-B. Based on this identification, the nodes **50**, **100**, and **140** in three different networks are using the same Point Code 2-B, and the nodes **70** and **110** in two different networks are using the same Point Code 2-A.

Because of this numbering plan characteristic, the licensed operator networks **20** and **30** each define an external numbering plan where an alias Point Code is assigned to each actual Point Code for the nodes of the adjacent licensed operator network from the perspective of each licensed operator network. For example, from the perspective of the first licensed operator network **20**, the nodes **90**, **100**, and **110** (of the second licensed operator network **30**) are referenced with the alias Point Codes 2-I, 2-K, and 2-H, respectively, and from the perspective of the second licensed operator network **30**, the nodes **50** and **70** (of the first licensed operator network **20**) are referenced with the alias Point Codes 2-X and 2-W, respectively. From the perspective of each licensed operator

network, its own numbering plan is valid to identify its own respective nodes, and then the external numbering plan with the alias Point Codes is used to route messages to nodes of different licensed operator networks which use the same numbering plan.

Using this approach within the national telecommunication network **10**, an outgoing signaling message is sent from originating node **50** (in the first licensed operator network **20**) to terminating node **110** (in the second licensed operator network **30**), these nodes **50, 110** are recognized by the first licensed operator network **20** within its own numbering plan with the actual Point Code 2-B (for the node **50**) and the alias Point Code 2-H (for the node **110**). Then, the node **50** sends the outgoing signaling message **180** to the Border Node **70** (which acts as a Signaling Transfer Point (STP)). The signaling message **180** includes an Originating Point Code (OPC) equal to 2-B (own actual Point Code according to own numbering plan) and a Destination Point Code (DPC) equal to 2-H (destination alias Point Code according to own numbering plan).

When the Border Node **70** receives the signaling message **180**, it determinates based on the DPC that the destination node is located in an adjacent network (the second licensed operator network **30**) and selects the Link Set (LS 2-I) **160** to route the signaling message **180**. But if MTP Point Code Mapping method is activated, then for all outgoing signaling messages to an adjacent network, the Border Node **70** first checks if there exists a Mapping Table associated to the Selected Link Set **160**. If so, then the Border Node **70** accesses the Mapping Table **190** (associated with Link Set **160**) for mapping from the own numbering plan to external numbering plan of the second licensed operator network **30**. In this case, the OPC 2-B is mapped to the corresponding external value 2-X (i.e., an alias Point Code in the second licensed operator network **30**) and the alias DPC 2-H is mapped to the corresponding external value 2-A (i.e., an actual Point Code in the second licensed operator network **30**) from the perspective of the first licensed operator network **20**. Then, the Border Node **70** replaces the old OPC 2-B by the new External Originating Point Code (EOPC) 2-X (an alias) and the old DPC 2-H (an alias) by the new External Destination Point Code (EDPC) 2-A (from the perspective of the first licensed operator network **20**) and sends the signaling message

180 to the adjacent Border Node **90** (in the second licensed operator network **30**) via the Link Set **160**. The node **90** recognizes the EOPC and EDPC as valid (according its own numbering plan) and routes the message **180** to the final destination node **110** because the DPC = 2-A is the identification of this node according to the own numbering plan of the second licensed operator network **30**.

Turning now to FIG. 2, it shows a block diagram of a typical SS7/C7 network, where the MTP Point Code Mapping method is used in the scenario of receiving incoming messages, which is described in the same national telecommunication network **10** described in the FIG. 1, where the Border Node **70** of the first licensed operator network **20** supports MTP Point Code Mapping. In this embodiment an incoming signaling message (from the perspective of the first licensed operator network **20**) is sent from originating node **110** (in the second licensed operator network **30**) to terminating node **50** (in the first licensed operator network **20**). These nodes **50, 110** are recognized by the second licensed operator network **30** within the its numbering plan with the alias Point Code 2-X (for the node **50**) and the actual Point Code 2-A (for the node **110**). The node **110** sends a signaling message **200** to the Border Node **90.** The signaling message **200** includes the OPC equal to 2-A (own Point Code according to its numbering plan) and DPC equal to 2-X (destination Point Code according to its numbering plan).

When the Border Node **90** receives the signaling message **200**, it routes the signaling message **200** to the Border Node **70** through the Link Set **160** by using the OPC = 2-A and DPC = 2-X because the node **90** does not support MTP Point Code Mapping method based on the characteristic described in the FIG.1 that for the Border Nodes **70** and **90** which are interconnected by the Link Set **160**, only one Border Node (in this case the Border Node **70**) has activated the MTP Point Code Mapping method for the Link Set **160** and therefore this node performs the MTP Point Code Mapping for outgoing and incoming signaling messages. Otherwise, a circular routing condition between Border Nodes **70** and **90** occurs because of double mapping if both Border Nodes have the MTP Point Code Mapping method active.

When the Border Node **70** receives the incoming signaling message **200** from the Link Set **160**, if the MTP Point Code Mapping method is activated, then for all incoming messages from an adjacent network, the Border Node **70** first checks if there exists a Mapping Table associated to the Link Set **160** on which the signaling message is received. If so, then the Border Node **70** accesses the Mapping Table **190** (associated with Link Set **160**) for mapping from the external numbering plan (of the second licensed operator **30**) to its numbering plan. In this case, the OPC 2-A (i.e., an actual Point Code in the second licensed operator network **30**) is mapped to the corresponding own value 2-H (i.e., an alias Point Code in the first licensed operator network **20**) and the DPC 2-X (i.e., an alias Point Code in the second licensed operator network **30**) is mapped to the corresponding own value 2-B (i.e., an actual Point Code in the first licensed operator network **20**). At that moment, the Border Node **70** replaces in the signaling message **200** the old OPC 2-A by the new OPC 2-H and the old DPC 2-X by the new DPC 2-B and sends the signaling message **200** to the Terminating Node **50**, because DPC 2-B is the identification of this node according to the own numbering plan of the licensed operator network **20**.

Turning now to FIG. 3, it shows a flow chart of MTP Point Code method used for outgoing signaling message, which summarizes the procedure to provide MTP Point Code Mapping method in the Border Node **70** located in a first network (described in the FIG. 1) during the scenario of outgoing signaling message. The procedure starts in step **210** when the Border Node receives (when the node acts as STP) or originates (when the node acts as SEP) in its Message Transfer Part (MTP) an order to send an outgoing message. The message includes the actual OPC and alias DPC according to the own numbering plan. Then, the MTP of the Border Node selects the Link Set over which the outgoing messages are sent toward the destination node located in a second network (typically, the routing information contained in the message is used to select the Link Set, in other words, the DPC is used to select a Link Set and the Signaling Link Selection (SLS) is used to select the link within the Link Set on which to place the message). In step **220**, a verification is performed in order to check whether the selected Link Set supports MTP Point Code Mapping, in other words, if

there exists a Mapping Table associated to the selected Link Set because the message will be delivery to the second network through of the selected Link Set, which acts as an signaling interface toward the second network. For instance, where the Link Set does not support MTP Point Code Mapping, the MTP of the Border Node proceeds to deliver the signaling message in a normal way (step **270**). But in the case where the determination is that the Link Set supports MTP Point Code Mapping, the actual OPC and alias DPC (from the perspective of the own numbering plan of the first network) are extracted from the signaling message (step **230**), and selection of the MTP Point Code Mapping Table associated to the Link Set is performed in step **240** (this step is done in base to the Link Set identification, which is used as a pointer toward the associated Mapping Table of the set of Mapping Tables which is stored in the database). After that, a mapping function is performed in step **250**, where the actual OPC and alias DPC are mapped from the own numbering plan to the corresponding alias OPC and actual DPC value in the external numbering plan. Afterwards, the MTP of the Border Node replaces in the signaling message the old OPC and DPC by the new alias OPC and new actual DPC (step **260**) and the message is delivered to the destination node in step **270**.

Turning now to FIG. 4, there is shown a flow chart of MTP Point Code method used for incoming signaling message, which shows a sequence for performing MTP Point Code Mapping in a Border Node **70** (described in the FIG. 2) during the scenario of incoming signaling message. The procedure starts in step **280** when the Border Node receives in its Message Transfer Part an incoming signaling message from a second network. The incoming signaling message includes the actual OPC and alias DPC according to the external numbering plan. Upon receipt of the incoming signaling message, the MTP of the Border Node verifies in step **290** whether the Link Set (where the incoming signaling message was received from) supports MTP Point Code Mapping, in other words, if there exists a mapping Table associated to the Link Set because the signaling message is received from an adjacent network. Upon determining that the Link Set does not support MTP Point Code Mapping, the MTP Border Node proceeds to deliver the incoming signaling message in a normal way (step **340**). But in the case where the determination is that the Link Set supports MTP Point Code

Mapping, the actual OPC and alias DPC in a external numbering plan are extracted from the incoming signaling message (step **300**) and the MTP Point Code Mapping Table associated to the Link Set in step **310** is selected (this step is done in base to the Link Set identification, which is used as a pointer toward the associated Mapping Table of the set of Mapping Tables which is stored in the database). After that, a mapping function is performed in step **320**, where the actual OPC and alias DPC are mapped from the external numbering plan to corresponded alias OPC and actual DPC values in the own numbering plan. After the MTP of the Border Node replaces in the incoming signaling message the old actual OPC and alias DPC by the new alias OPC and actual DPC (step **330**), the message is delivered to the destination node in the first network in step **340**.

FIG. 5 depicts a functionality of network node and elements of a database for MTP Point Code Mapping. Wherein the network node **350** (in this case a Border Node) is composed by Signaling Data Link (MTP level 1) **360**, Signaling Link (MTP level 2) **370**, Signaling Network (MTP level 3) **380** and User Part (MTP level 4) **450**. Additionally MTP Point Code Mapping **390** including database **400** of MTP Point Code Mapping Tables **410** are shown as functions of Signaling Network (MTP level 3) **380**.

The MTP Point Code Mapping **390** translates (using the MTP Point Code Mapping Tables **410**) the actual OPC and alias DPC from own numbering plan to alias OPC and actual DPC in external numbering plan for the signaling messages coming from User Part (MTP level 4) **450** (outgoing messages) and for incoming signaling messages (signaling messages coming from Signaling Link (MTP level 2) **370**), the MTP Point Code Mapping **390** translates from external numbering plan (actual OPC and alias DPC) to own numbering plan (alias OPC and actual DPC).

Each MTP Point Code Mapping Table **410** is associated to a specific Link Set, but each MTP Point Code Mapping Table **410** can be used for several Link Sets at same time. Typically, these MTP Point Code Mapping Tables **410** could logically reside in the database **400** in the MTP software processed by the network node (STP or SEP).

The appropriate MTP Point Code Mapping Table **410** could be selected based on the Link Set identification (field **420** of the database structure) that the message arrive on (for the case of incoming message) or when the Link Set is selected to route a message (for the case of outgoing message). This Link Set identification represents the origin or destination of the signaling messages. The MTP Point Code Mapping Tables **410** could then use the OPC and DPC of the signaling message to select new or translated OPC and DPC based on the direction (incoming or outgoing) of the signaling message, where for the case of incoming signaling message the column **440** (External numbering plan) the actual OPC and alias DPC are used as index in said column **440**, in order to translate the actual OPC and alias DPC to the corresponding alias OPC and actual DPC values of the column **430** (Own Numbering Plan) and for the case of outgoing signaling message the column **430** (Own Numbering Plan) the actual OPC and alias DPC of the signaling message are used as index in said column **430**, in order to translate the actual OPC and alias DPC to the corresponding alias OPC and actual DPC values of the column **440** (External Numbering Plan).

Because the MTP Point Code Mapping method acts on signaling as entering MTP level 3 processing, multiple kind of network nodes can be accommodated such as Telephone Switch, Mobile Switching Center, Home Location Register, Authentication Center, Signaling Control Point, Signaling Switching Point, Billing Center, Message Center, Signaling Data Point, Visitor Location Register, Mobile Positioning Center, Operation & Maintenance Center, etc. These nodes use the MTP service and therefore the MTP Point Code Mapping is applicable to several market (for example ITU-T, Chinese (MPT) and Japanese (TTC) markets, etc.)

The MTP Point Code Mapping allows to have several licensed operator networks using the same Point Code numbering plan and therefore to assign Point Codes independently. Also, based on that MTP Point Code Mapping method includes a MTP Point Code Mapping Tables for the Link Set that connects the Border Node in the first licensed operator network to an adjacent Border Node in the second licensed operator network. This may allow to global or dominant licensed operator network may have the control of the MTP Point Code Mapping in its Border Node and therefore

improves the inter-working coordination with the others licensed operator networks, in other words, the dominant licensed operator network may perform the MTP Point Code Mapping activities for incoming or outgoing signaling messages for the national network and therefore there is no coordination impact for the others licensed operator networks and therefore to protect to the licensed operator networks from routing problems such as circular routing due to duplication of point codes in each domain, or faulty management due to broadcast of fault transfer prohibited messages between networks.

Although the invention has been described with reference to specific embodiments, this description is not meant to be constructed in a limited sense. The various modifications of the embodiments, as well as alternative embodiments of the invention, will become apparent to person skilled in the art upon reference to the description of the invention. It is, therefore, contemplated that the appended claims will cover such modifications that fall within the scope of the invention, or their equivalents.